Surface Waters and Wetlands Inventory: A More Comprehensive Data Set of the Nation's Water Resources

Often referred to as Version 2.0 of the National Wetlands Inventory, the Surface Waters and Wetlands Inventory provides more inclusive geospatial data of all wetlands and surface water features. This national geospatial data product will contribute substantially to improved modeling of flow and water movement in surface water basins, channels, and wetlands.

By Thomas E. Dahl

Wetlands are an essential component of the nation's surface water network and it is widely accepted that wetlands and hydrology are closely linked either through the exchange of water, nutrient cycling, or other ecological processes (Cooper & Merritt 2012; Mitch & Gosselink 2007; Kaufman et al. 2005; Cowardin & Golet 1995). Hydrological data models have been created to represent water flow for use with geospatial information. The ESRI Arc Hydro (surface water) Model and the National Hydrography Dataset Hydro Network are examples. However, these hydrologic models are incomplete, as they do not include all surface water features. Hydrologic models used for ecological or landscape-level applications need to include wetland geospatial data, as it is essential to understand the interactions between wetlands and other surface waters.

Unfortunately, the integration of geospatial hydrography and wetlands data in the United States is not a simple matter, as the two data sets have been developed independently, using different standards and for different purposes. Currently, the wetland data contained in the U.S. Fish and Wildlife Service's (FWS') National Wetlands Inventory (NWI) requires augmentation to include linear wetland information and linear stream data originally collected by the NWI but never translated to a digital format. Additional hydrography information, specifically stream segments and connectors, also needs to be included. This augmentation process forms the basis for the development of the Surface Waters and Wetlands Inventory (SWI) and is discussed here.

In addition to the ecological importance of establishing hydrologic connections between wetlands and other surface waters, there are regulatory ramifications. Since the U.S. Supreme Court decision of 2001 (*SWANCC*) established a distinction between isolated wetlands and wetlands with connections to waterways for federal regulatory purposes, the importance of determining hydrologic connectivity on the landscape has taken on added significance. Although regulatory jurisdiction is determined on a case-by-case basis, the SWI data set provides additional information to help identify and quantify isolated wetlands.

The purpose of developing the SWI is to provide a more comprehensive data set inclusive of all wetlands and surface water features and to focus efforts on providing the base data for geospatial models designed to examine linkages between surface waters and wetlands. Understanding the biodiversity values associated with different surface water features is an important factor in achieving many strategic conservation goals. The synthesis of this water resource information is crucial to an array of users and aids efforts to produce national products that move toward predictive, multiscale, system-focused actions for resource assessment (Dahl & Griffin 2012).

Legacy Wetlands Mapping of the NWI

The FWS is the principal federal agency providing information to the public and other agencies on the extent and status of the nation's wetlands. The FWS has the lead responsibility for coordinating the national coverage and stewardship of the wetlands data theme that comprises the Wetlands Layer of the National Spatial Data Infrastructure.

The FWS' NWI program has been mapping the nation's wetlands for the past 35 years and has produced wetland map information for a large part of the conterminous United States, all of Hawaii, Puerto Rico, the U.S. Virgin Islands, Guam and Saipan, and 35% of Alaska. Over time, there have been many technological innovations and improvements in geospatial science and geographic information systems. However, the fundamental process used by the NWI for identifying and delineating wetland and deepwater boundaries to produce medium-resolution information on the location, type, and size of these habitats has remained, and the data are considered the authoritative source for wetland geospatial information for the nation (FGDC 2009).

Because of cartographic limitations and the scale of the imagery used for the original NWI map products, many narrow wetland features, such as streams, canals, ditches, and some narrow vegetated wetland segments, were initially mapped as linear (single-line features) rather than polygonal features. There were challenges presented by cartographic display of linear features, as they may have formed the edge of vegetated wetlands, flowed through larger wetland complexes, or changed classification based on stream reach, substrate type, or presence of aquatic vegetation (Figure 1). These cartographic limitations have led to issues relating to connectivity of channels to wetland

basins or other hydrologic features. These line features had no spatial area and consequently were not included in many landscape-level analyses, data summaries, assessments, or water-resource models. In some regions of the country, mapping linear surface water channels was often a lower priority, since NWI wetland maps were designed as topical overlays to topographic base maps that already displayed perennial and intermittent rivers and streams. However, these narrow features often represented important connections between larger wetlands and other surface waters and contributed to understanding ecological functions and landscape-level analyses.

Assembling the SWI Data Set

The SWI data set is a more comprehensive characterization of all surface water features on the landscape. It stems from the need to represent all surface waters and wetlands as polygons in a geospatial data set to facilitate accurate area calculations and provide consistent, standardized ecological classification to allow for adaptive management, geospatial summaries, and modeling. The SWI has been created by retaining the wetland and deepwater polygons that compose the NWI digital wetlands spatial data layer. The water bodies, already contained within the NWI data and classified as deepwater habitats using the Cowardin et al. (1979) nomenclature, are retained as they provided ecological descriptors of habitat types (Figure 2).

These wetlands and deepwater features have been supplemented by reintroducing any linear wetland or surface water features that were orphaned from the original NWI hard copy maps and converting them to narrow polygonal features. The NWI wetland classification attribute is retained for these narrow features. Additionally, the data are supplemented with hydrography data as a secondary source for any single-line stream features not mapped by the NWI and to complete segmented connections (Figure 3). These features are assigned a Cowardin classification to conform to federal national mapping standards and buffered to become polygonal features as described above. A geoprocessing model addresses geospatial dominance issues, such as water bodies traversing through wetlands, and the translation of connecting NWI classified features with unclassified hydrography data. It also updates all existing NWI classifications to current standards. The resultant data set is a more complete depiction of surface waters and wetlands.

Due in part to how wetlands were mapped in the past, coupled with improved geospatial processing techniques, the SWI data set is a departure from the legacy NWI data in several ways. The SWI depicts all surface water and wetland features in a single database; it applies the Cowardin et al. (1979) system to provide consistent ecological descriptors intended to address wetlands and water bodies; and it imparts new and improved information about wetland extent and hydrologic connectivity.

The ramifications of generating the SWI data are substantial in terms of providing a more comprehensive inventory of wetland and associated water bodies. Table 1 indicates the increased number and area of mapped features from the legacy NWI data to the SWI. Recognizing the difference between these two data sets has implications for past wetland data summaries and modeling that has been generated using the legacy NWI map data.
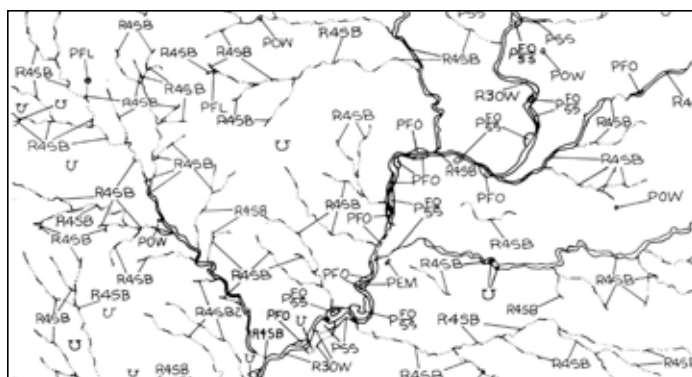

Figure 1: Legacy data of the NWI (circa 1980s) show a mixture of wetland polygonal features and intermittent linear riverine segments (R4SB).
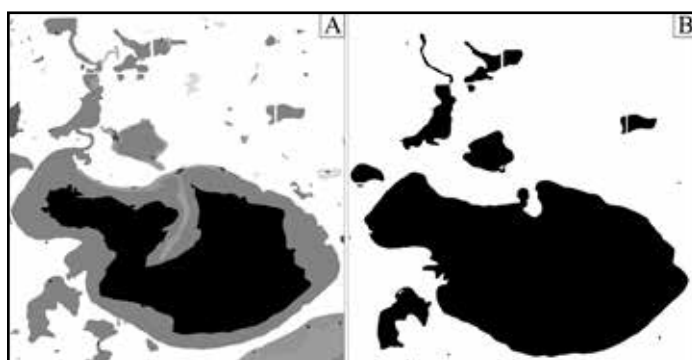

Figure 2: A comparison of mapped water bodies around Lake Henry, Kingsbury County, South Dakota. This graphic shows the open water bodies (black) and associated wetlands (shades of gray) between the SWI data (A) and the National Hydrography Dataset (B). NWI data were incorporated into the SWI data set, as it provided greater accuracy of littoral/limnetic boundaries, a consistent, standardized classification (classification attributes not shown in this example), and greater resolution of surface water boundaries.
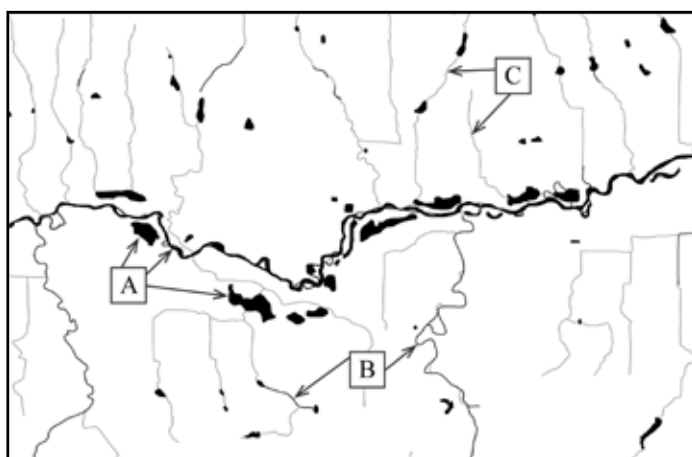

Figure 3: An example of SWI mapping shows a composite of all surface waters and wetlands. Wetland polygonal features were retained from the NWI data set (A) and combined with orphaned wetland linear features that were buffered to narrow polygons (B) and hydrology linear segment connectors also buffered and assigned ecological classification (C). In this example, classification attributes are not shown.

State	NWI (legacy map data)		SWI		SWI Increase		SWI Percent Increase	
	No. mapped features	Acres	No. mapped features	Acres	No. mapped features	Acres	No. mapped features	Acres
Ala.	232,483	3,680,294	460,839	3,918,227	228,356	237,934	98 %	6 %
Minn.	1,468,162	13,210,348	1,696,478	13,368,829	228,316	158,481	16 %	1 %
Neb.	443,474	1,042,141	779,060	1,351,676	335,586	309,535	76 %	30 %
N.M.	44,377	305,377	184,883	843,283	96,774	537,907	218 %	176 %
Okla.	514,326	1,857,458	848,452	2,222,127	334,126	364,669	65 %	20 %
Or.	266,467	2,205,601	992,172	2,883,668	725,705	678,067	272 %	31 %
R.I.	18,148	107,354	29,946	110,093	11,798	2,739	65 %	3 %
Wash.	179,252	1,463,309	615,108	2,052,619	435,856	589,310	243 %	40 %
Total	3,166,689	23,871,882	5,606,938	26,750,522	2,396,517	2,878,640	μ = 76 %	μ = 12 %

Table 1: Comparison of the number and area of wetland and water bodies mapped from the existing NWI database and the SWI database for eight geographically dispersed states.

SURFACE WATERS AND WETLANDS DATA APPLICATIONS (HYDROLOGY AND MODELING)

There are many opportunities to apply SWI data to assist in resource management, planning, and strategic habitat conservation efforts. Applications include various geospatial analyses, tracing contaminant pathways through aquatic systems, identifying and prioritizing habitat restoration opportunities, examining continuity or dissection of habitat corridors, quantifying aquatic and wetland resource types, and facilitating ecological modeling.

Modeling changes at the community level (e.g., species richness, diversity, cover, and biomass) are often linked to the hydrologic characteristics of wetlands or the surface water bodies adjacent to wetlands. As examples, some models have been developed to aid in the design of flow regimes for the purpose of enhancing recruitment for wetland/riparian forest restoration projects (Rood et al. 2005); other models predict the responses of wetland plant communities to water-level changes (Wilcox & Xie 2007). Fitz (2010) indicated that hydrology was an important consideration in the spatial and temporal scales of any modeling involving wetlands. Current hydrography that attempts to trace surface water flow is often incomplete or misleading because it lacks one or more of the landscape-level components that make up surface water features. The SWI data set provides more complete geospatial data on surface waters and wetlands than has been available in the past and will provide a more efficient means to make determinations of flow and water movement in surface water basins and channels as well as in wetlands (Figure 4). The SWI database has been completed for 28 states in the conterminous United States and will be publicly available in March 2013 at: http://www.fws.gov/wetlands/. ■
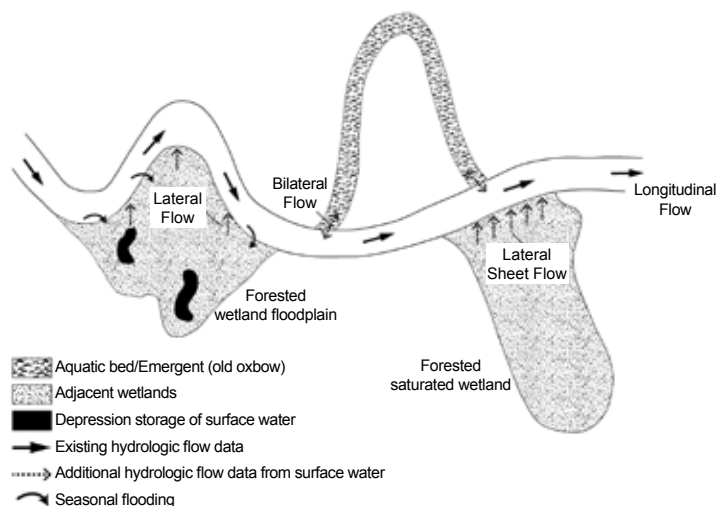

Figure 4. This hypothetical situation illustrates the potential for advanced hydrologic modeling using SWI data.

tributed time and effort to preparation of documentation and web development. Technical support for data assimilation and web mapping services were provided by the U.S. Geological Survey's National Geospatial Program and the Wisconsin Water Science Center. Andy Robertson, St. Mary's University of Minnesota, provided review of the geospatial buffering process in selected physiographic regions in Minnesota and further coordinated preparation of this article.

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tions wetlands make in order to gain long-term support for wetland protection and conservation activities. Delaware is beginning to use wetland maps to understand and communicate wetland services on a watershed scale, and determine the economic value of each service wetlands provide. Wetland condition assessments are being completed by watershed including targeting restoration sites on wetland maps. The most recent mapping of Delaware wetlands occurred in 2007 in partnership with the NWI. Mapping data analysis revealed wetland loss, gain, and change over a 15-year period and led to the production of a wetland status and changes report for Delaware.

California has embarked on a project to develop a statewide map of surface waters and riparian areas. When completed, the California Aquatic Resource Inventory (CARI), which includes wetlands, streams, and riparian areas, will provide one comprehensive map that can be used by citizens as well as local, state, and federal agencies to manage and conserve all aquatic resources. It will support the state's well-established watershed approach to managing scarce aquatic resources. This is a multiagency, multiscale effort. The CARI workgroup will include cities, counties, parks, state agencies, federal agencies, and nonprofit organizations. These are also the parties that will use the map when it is completed.

Consistent with approaches in other states, the Oregon Department of State Lands is working on updating its state wetland maps, incorporating information about wetland health and collaborating with multiple agencies to identify wetland restoration priorities statewide. One of the applications of this information will be to provide it to local watershed groups to incorporate into their watershed planning activities.

One of the most ambitious efforts to link wetland maps with wetland health is the U.S. Environmental Agency's (EPA's) National Wetland Condition Assessment (NWCA). In the summer of 2011, EPA, in collaboration with states and other federal partners, visited wetlands throughout the United States to evaluate their aquatic health. Thirty-seven states actively participated in the field sampling. The sites were selected from the same sample frame of mapped wetlands mapped by the U.S. Fish and Wildlife Service's NWI to conduct their status and trends reports, which have measured the annual losses and gains in wetland acres dating back to the 1950s. The results of this nationwide analysis is expected to be published in late 2013 or early 2014 and will be the first report on the overall health of wetlands in the lower 48 states.

Wetland maps are not only to assist governments in carrying out programs. They are also useful to individual citizens. For example, the Wisconsin Department of Natural Resources (WDNR) asked members of private industry how they could help them reduce their footprint on wetlands. The response was that if commercial interests knew the likelihood wetlands were present before making a decision to purchase a property, they would be better able to avoid impacts to wetlands. Wisconsin now has a wetland indicator map that displays wetlands and potential wetlands (wet soils). The WDNR, the

Wisconsin Realtors Association, and the Wisconsin Wetlands Association partnered to develop a real estate addendum for wetlands. It allows a buyer to determine if there are wetlands present on a property and negotiate a remedy with the seller, if needed, prior to the purchase of the property.

Florida is a state surrounded on three sides by ocean. There are many applications for private docks. Using maps that include coastal features, wetlands, and the locations of high-quality vegetation, such as eelgrass beds, the state and the U.S. Army Corps of Engineers have developed a self-certification program for single-family docks. The ability of the state to utilize maps to enable citizens to self-certify activities with a small footprint has reduced the time required to obtain a permit for a dock from 3-6 months to 1-30 days.

There are many more examples of ways that wetland maps are being used to improve and expedite decisionmaking. Creating and updating wetland maps requires a significant outlay upfront, but the potential return on the investment to government, industry, and individual citizens is enormous. In 2008, the Association of State Wetland Managers and other partners established the Wetland Mapping Consortium to improve management of wetland resources by fostering a better understanding of wetland mapping and monitoring techniques and applications. The Wetland Mapping Consortium fosters collaboration and hosts monthly webinars on wetland mapping. Membership is free and open to anyone interested in developing or using wetland maps. For more information visit aswm.org.

Without the NWI, the projects described above and many others across the country would not have been possible. The ability to map wetlands using consistent standards across the country has been essential to the advancement of wetland science. NWI mapping and the collaboration among agencies and organizations have been and will be critical to conserving, restoring, and protecting the nation's wetlands. ∎

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